Vensim

introduction

Introduction

Simulation

A Simulation is the imitation of the operation of a real-world process or system over time.

Brief Explanation

- The behavior of a system as it evolves over time is studied by developing a simulation model.
- This model takes the form of a set of assumptions concerning the operation of the system.

The assumptions are expressed in

- Mathematical relationships
- Logical relationships
- Symbolic relationships

Between the entities of the system.

Modeling

Model – simplified representation of a system – e.g. using mathematical equation

We simulate a model to study the behavior of a system – need to verify that our model is correct – expect results

Knowing how to use Simulink or Vensim does not mean that you know how to model a system

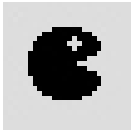
Types of Models

The various types models are

- Mathematical or Physical Model
- Static Model
- Dynamic Model
- Deterministic Model
- Stochastic Model
- Discrete Model
- Continuous Model

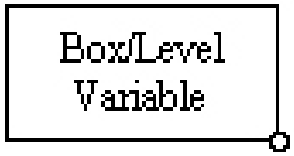
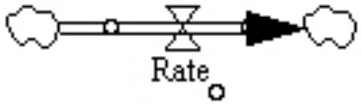
Vensim

- Vensim PLE is software designed for modeling one or more quantities that change over time.

	The Selection button allows you to select or drag an object
	The Lock button freezes the screen, preventing you from changing the contents of the Vensim PLE window.
	Some good humor from the designers of Vensim PLE -- this icon is the delete button. Select it, then click on an ojbect to delete that object.

Building the Model

- **Step 0: Basic Building Blocks**

	Box Variables represent quantities. These are the main "nouns" in a system and are sometimes refered to as Level Variables.
	Rates represent changes over time. These are the main "verbs" in a system and are sometimes refered to as Flows.
	Auxiliary Variables represent constants and other parameters. These loosely corespond to "adjectives" and "adverbs" in a system.
	Connectors indicate dependencies between objects. In other words, I need to know this to calculate that.

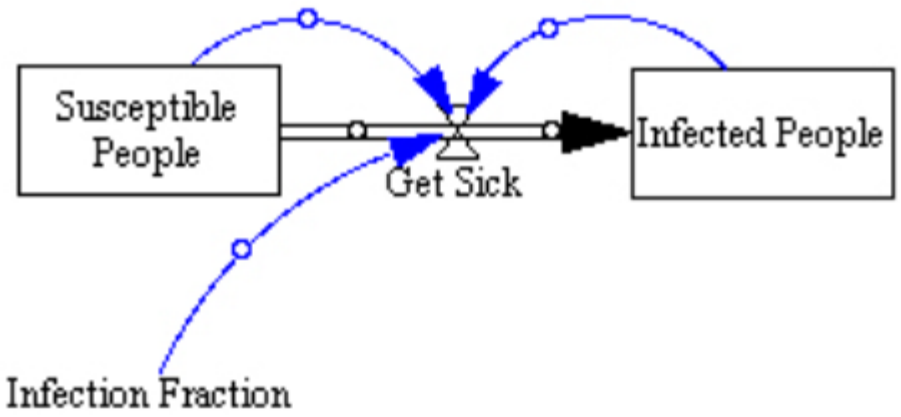
Building the Model

- **Step 1 : Adding Box Variables**

  In this example, you will model the following situation: On a Monday, 100 students return to school, one of whom has the flu. As time passes, the sick student infects his classmates, who in turn go on to infect others. This could be generalized as follows:

  Over time, susceptible people get sick and become infected people.

  To begin building the model, create two box variables: one for *Susceptible People* and one for *Infected People*. These will allow you to keep track of how many healthy and sick people there are.



Building the Model

- **Step 2 Adding a Rate**
  - use a rate to connect these two box variables. The rate represents a place in the system where something happens. Since this rate represents the number of people who change from susceptible to infected, name it *Get Sick*.
- **Step 3 Adding an Auxiliary Variable**
  - Next, we will need an auxiliary variable to help calculate the rate at which susceptible people become infected people. call this variable *Infection Fraction*. Keep in mind that this is a coefficient and not a rate.
- **Step 4 Adding Connectors**
  - Finally, Vensim PLE needs instructions about which elements depend on each other. In this case, the rate Get Sick depends on the number of susceptible people, the number of infected people and the infection fraction. Therefore we need to add connectors from each of these variables to the rate *Get Sick*.

Specifying the Input

- **Step 0 What about data?**
  - At this point, your model should look something like the previous figure. Visually, you can see that susceptible people get sick and become infected people. The thin arching connector arrows suggest that this process is based on an infection fraction, the number of susceptible people, and the number of infected people.

  - The framework for the model is now in place, but you haven't given it any data yet. Before simulating the model, you must define how many susceptible people and how many infected people there are when the model starts (at time zero). You must also construct a formula for how people get sick and specify the infection fraction.

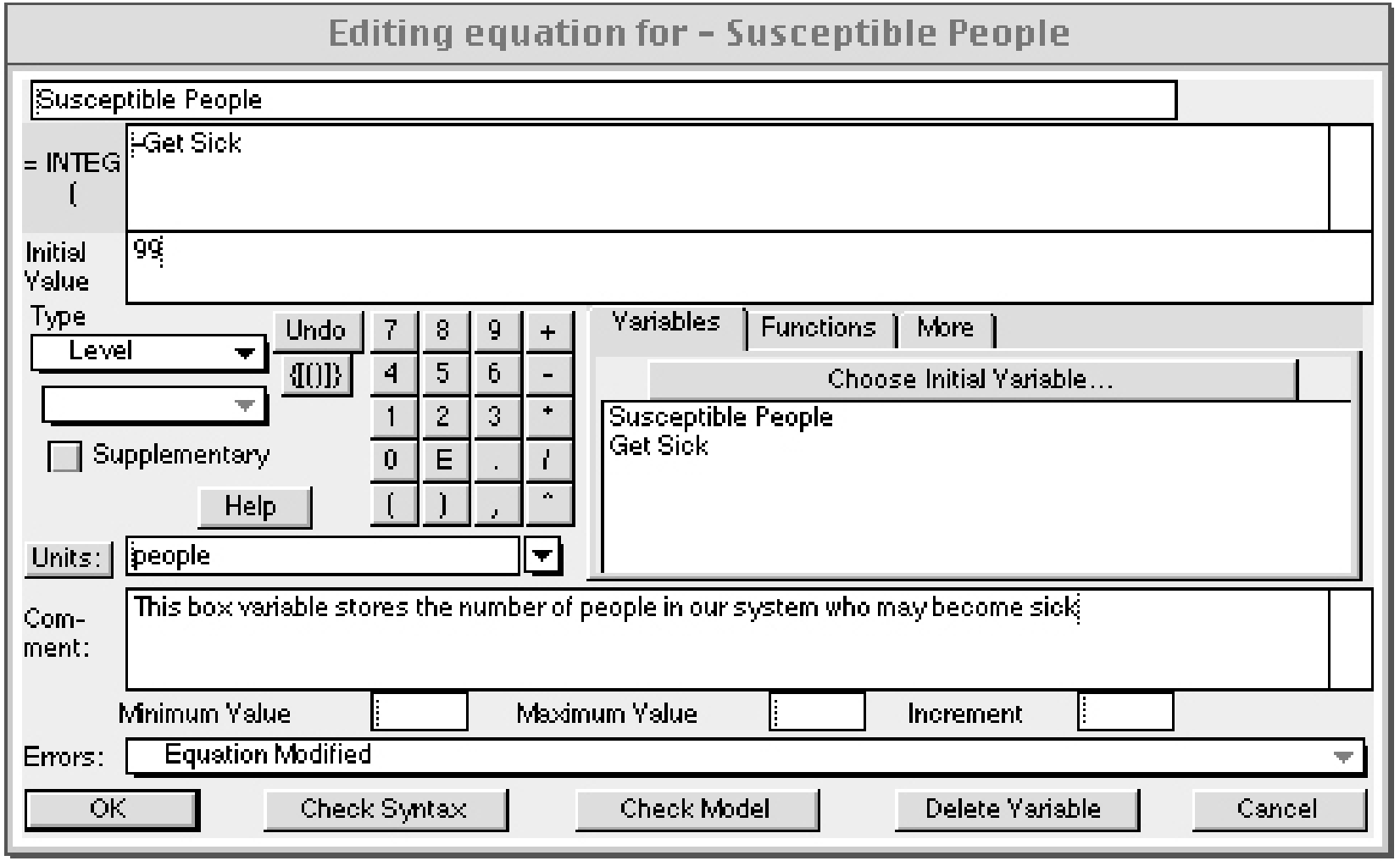
Specifying the Input

- **Step 1 Box Variables**
  - Recall that our hypothetical school has 100 kids. Set the initial number of susceptible people to 99 and set the number of infected people to 1.

Procedure:

- Click on the Equations button on the toolbar.
- Every object that now appears in black is not sufficiently defined.
- Click on *Susceptible People* and a window like the one below will pop up. This probably looks complex, but you won't need most of these options at first.
- The cursor should already be in the box to the right of the words Init Value. Here, type in 99.
- Next, click in the box to the right of Units and type people.
- Click OK in the bottom left of the window to finish.
- The procedure for setting the initial number of infected people is analagous, except of course that there is only 1 infected person at time zero.

Specifying the Input



Specifying the Input

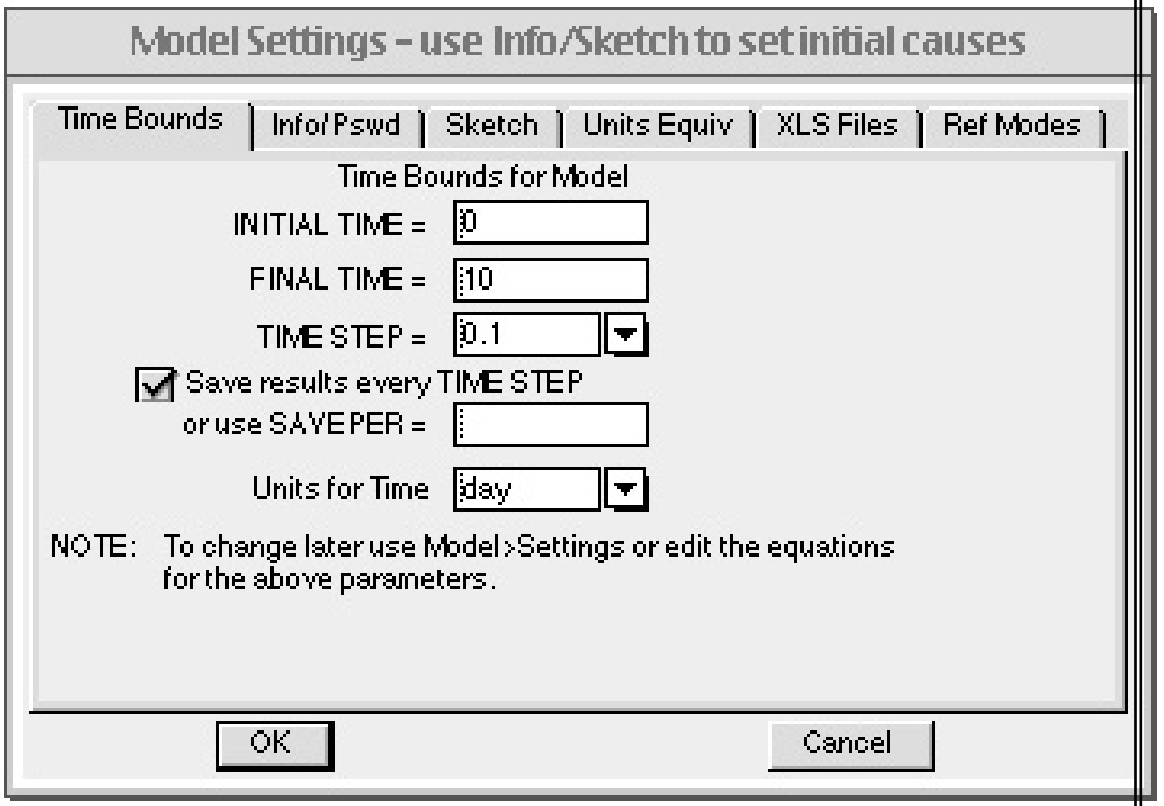
- **Step 2 Rate Equation**
  - Now, we need to define a formula for the rate *Get Sick*. Assume that every susceptible person interacts with every infected person once per day.
  - This can be expressed mathematically as *Susceptible People * Infected People*. Not every interaction results in an infection though, so multiply this total number of interactions by the *Infection Fraction* to get the number of people who get sick.

Specifying the Input

- **Step 3 The Infection Fraction**
  - Finally, we must specify a value for *Infection Fraction*. Assuming that in two days there will be three new sick students, the infection fraction can be estimated as 0.0151.

Running the Model

- Before simulating the model with the Run button , there are a few things left to specify.
  - **Model Settings**
  - **Checking Units**
  - **Run**



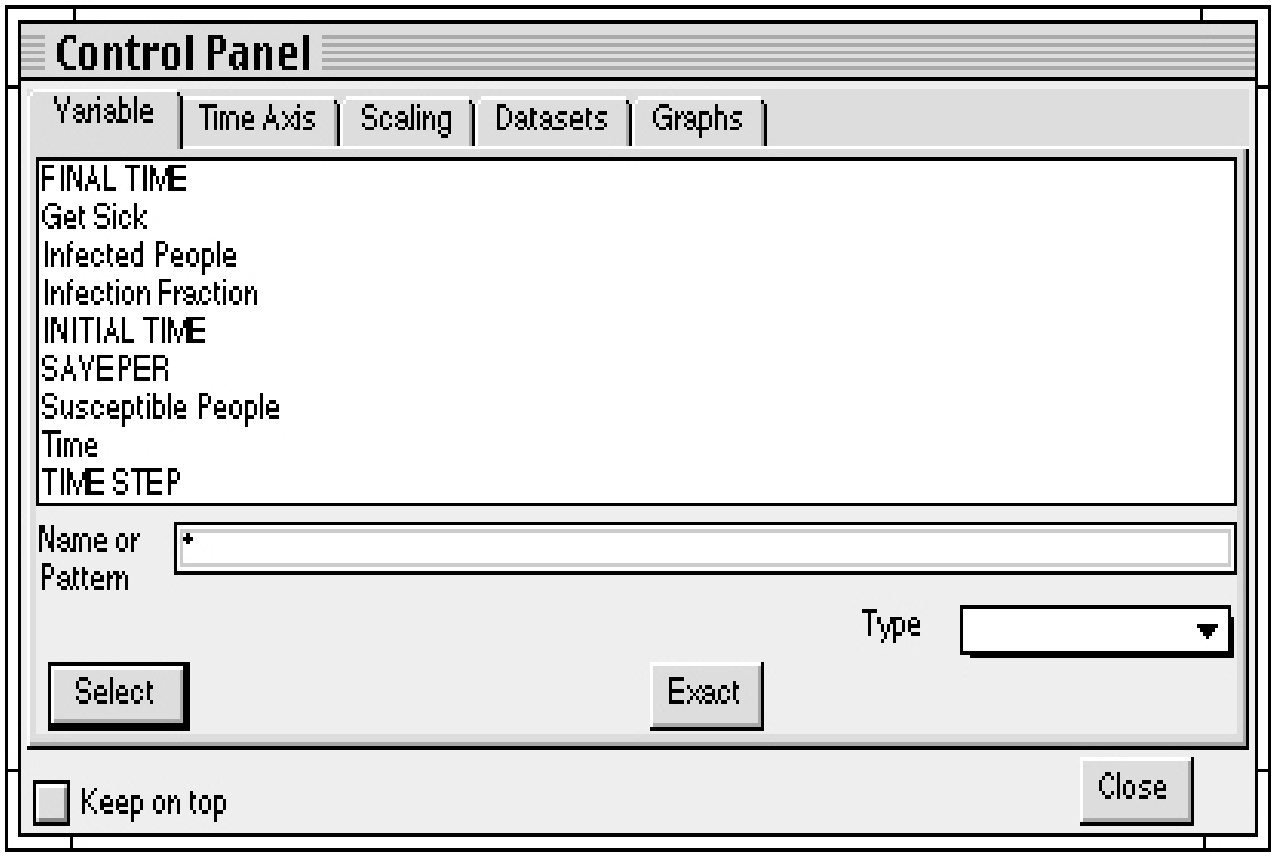
Examining the Output

- **Step 1 Quick Graphs and Tables**

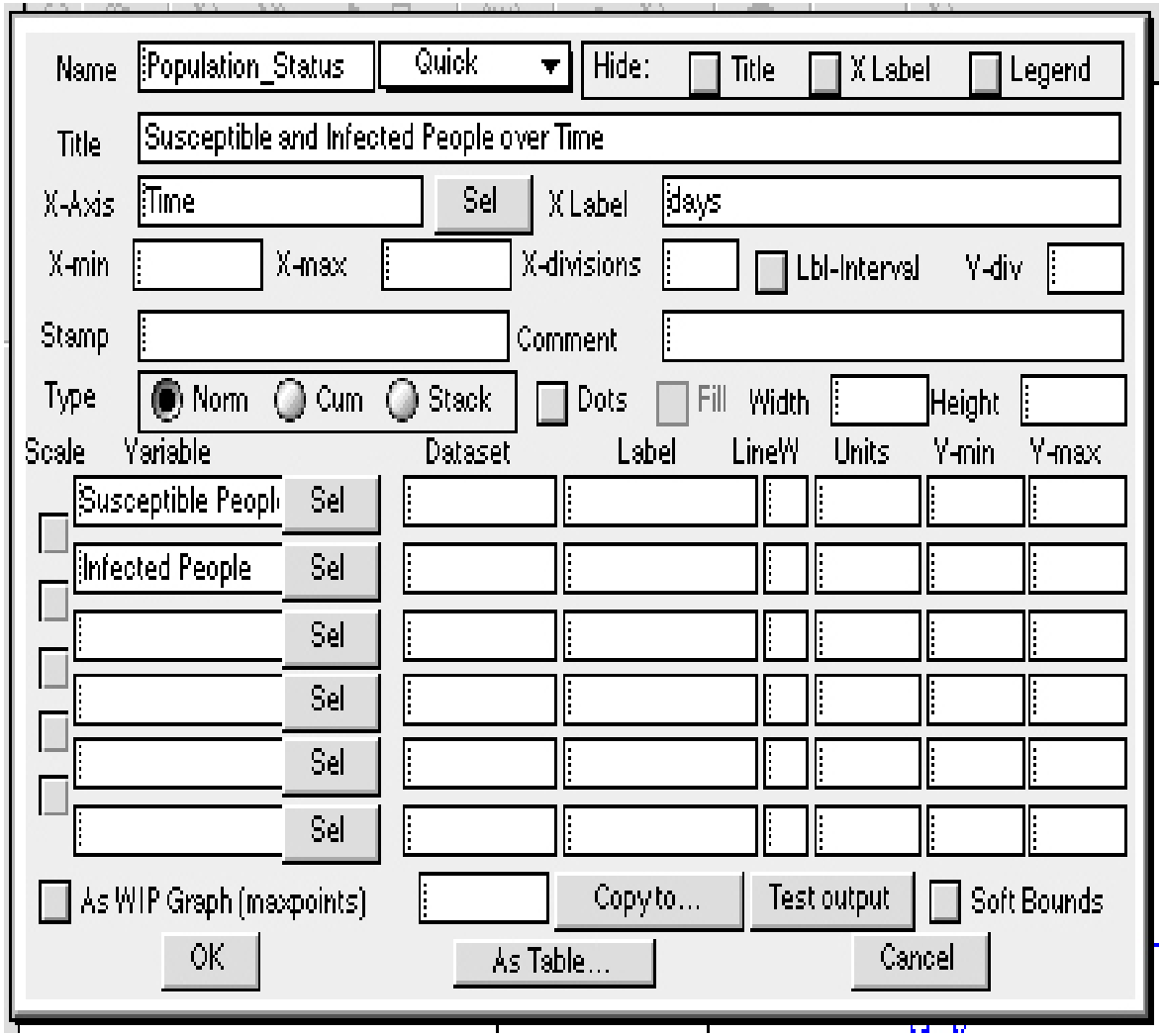
	Causes Strip - This brings up a strip graph for the selected variable and any variables affecting it in a causal loop.
	Graph - This brings up a graph of the selected variable over time.
	Table - Displays values for the selected variable horizontally.
	Table Time Down - Displays values for the selected variable over time vertically.

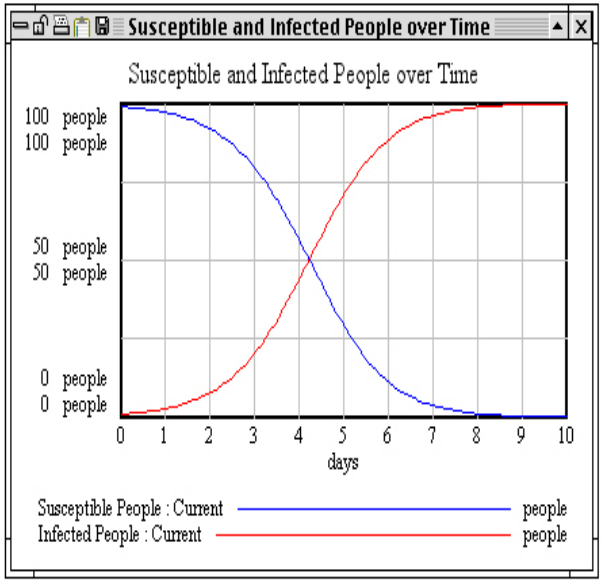
Examining the Output

- **Step 2 Custom Graphs and Tables**



Examining the Output





Examining the Output

- **Step 3 *SyntheSim***
  - Next to the standard Run button is the *SyntheSim* button . *SyntheSim* mode can add considerable interactivity to a model. Clicking this button turns all constant-valued auxiliary variables into slider bars. It also places small graphs inside the boxes containing the names of box variables and rates. When *SyntheSim* is on, any change you make will be immediately reflected in the graphs on each box variable and rate.
- **Procedure:**
  - Values of constant auxiliary variables can be adjusted by dragging the slider bars or clicking on them.
  - If you click on the arrows on the sides of the bars, a pop-up window will appear. In this window you can manually adjust the variable's value, or set the minimum, maximum and increment for that slider bar.

Examining the Output

- **Step 3 *SyntheSim***

	This button activates *SyntheSim* mode (A model must be ready to run before you can enter SyntheSim).
	This button exits *SyntheSim* mode.
	This button resets the selected slider to the value it had when *SyntheSim* was started.
	This button resets all of the sliders in the model.
	This button saves the current model settings and run data. SyntheSim Toolbar Buttons